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DOE/NASA CONTRACTOR REPORT

DOE/NASA CR-150744

QUARTERLY REPORTS FOR RS-600 PROGRAMMABLE CONTROLLER - SOLAR HEATING AND COOLING

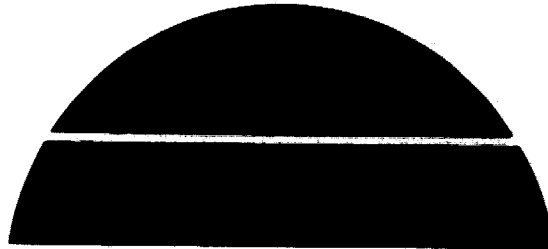
Prepared by

Rho Sigma
11922 Valeria Street
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Under Contract NAS8-32256 with

National Aeronautics and Space Administration
George C. Marshall Space Flight Center, Alabama 35812

For the U. S. Department of Energy



(NASA-CR-150744) RS-600 PROGRAMMABLE
CONTROLLER: SOLAR HEATING AND COOLING
Progress Report, 30 Oct. 1976 - 1 Jul. 1977
(RHO Sigma, Inc.) 28 p HC A03/MF A01

N78-29579

Unclas
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U.S. Department of Energy



Solar Energy

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RHO SIGMA, INC.

Contract NAS8-32256

First Quarterly Report (DRL-10)

February 1, 1977

December 7, 1976

TO: James D. Hankins
FROM: Joseph L. Imholte
Rho Sigma, Inc.
SUBJECT: Monthly Status Report
CONTRACT: NAS9-32256 Month Ending 30 November 1976

1. TECHNICAL PERFORMANCE

During the month ending 30 November 1976, Rho Sigma completed the preliminary research for the design of the microprocessor control subsystem. An industry survey was conducted for the requirements to be met by a microprocessor controller. Meetings were held with other companies in the solar industry and discussed their needs and requirements for the future. This industry survey is discussed further in Section IV.

A study was also started on the microprocessor field to enable Rho Sigma to best determine the type of microprocessor to be used which will allow the greatest system flexibility and still be competitive with the remainder of the industries.

Rho Sigma has completed their preliminary table of specifications for the controller and has an initial block diagram matching the requirements as determined by the above study.

cc: McMurray

II. Schedule:

Enclosure A shows, via bar chart, the progress Rho Sigma has made toward the completion of the contract. The requirement study is complete and work on the microprocessor study is nearing completion. The preliminary work on the system specification and block diagram is also complete.

III. Cost:

This item has been deleted.

IV. Industry Survey:

During the course of this reporting period, a number of industrial organizations were contacted to discuss requirements for advanced control systems.

These organizations included:

IBM, Huntsville, Alabama
Westinghouse, Baltimore, Maryland
General Electric, King of Prussia, Pennsylvania
A.O. Smith Company, Kankakee, Illinois
TRW Systems, Los Angeles, California
Solaron, Inc., Denver, Colorado

From these discussions several aspects of control systems requirements became apparent. One of the major problems with current controls results from the use of "two-stage" thermostats. This type of thermostat turns on the solar heat when a demand is present. If the room temperature continues to drop, indicating insufficient solar heat capacity available, the second stage cuts in generally about 2°F difference, turning on the back-up system. The problem arises when the thermostat is "set-back" at night time, and the house cools to a relatively low temperature (60-63°F). In the morning, the

"ENCLOSURE A"

0 1 2 3 4 5 6 7 8

CONTROLLER REQUIREMENT STUDY

MICROPROCESSOR STUDY

SYSTEM SPECIFICATION

BLOCK DIAGRAM DESIGN

SCHEMATICS

P.C. BOARD LAYOUT

FLOW CHART

PROGRAM LISTING

PROCURE MATERIAL

FABRICATION

ELECTRICAL DEBUG

PROGRAM DEBUG

TEST AND EVALUATION

ACCEPTANCE TEST

REPORTS-MONTHLY

QUARTERLY REVIEW

DEVELOPMENT PLAN

VERIFICATION (APP)

QUALITY ASSURANCE PLAN

DESIGN REVIEW

DOCUMENTATION

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thermostat is manually advanced to 70°F. Since the thermodynamic lag of the house is long, the difference between the instantaneous thermostat setting is 70°F - 63°F > 2°F. Hence, even if adequate solar energy is in storage, the back-up heater is energized to raise the room temperature. Another key point that became apparent is the increasing use of air systems. All of the major companies visited were using air for one or more applications. In many of the designs currently on the drawing board, the air systems need proportional position control of dampers. This will require servo-feed-back loops under operation of the controller.

A summary of the characteristics which are currently believed to be representative of needs are given in the matrix below:

<u>INPUTS</u>	<u>#</u>	<u>CHARACTERISTICS</u>	<u>OUTPUTS</u>	<u>#</u>	<u>CHARACTERISTICS</u>
Analog	16	mv D.C.	Servo	4	0 ± 24 VAC
Switch Closures	12	0-24V AC/DC	Switch Closures	8	0-10 AMPs/110VAC
Time	1	(Internal)	110VA	4	0-20 AMPs/24VAC
Digital Pulse Trains	4	0-10kc	Time Display (Plug-In)	1	Visual (Sonic)
			Porportional	4	110VAC @ 10 AMPs

Most of the companies interviewed had little or no idea of what the control needs would be for advanced solar systems that incorporated air conditioning (refrigeration) and energy conservation techniques in an intergrated package. The characteristics shown on page three must be treated as tentative and will be refined over the course of this work.

January 10, 1977

TO: James D. Hankins
FROM: Joseph L. Imholte
SUBJECT: Monthly Status Report
CONTRACT: NAS8-32256
PERIOD: Month Ending 31 December 1976

TECHNICAL PERFORMANCE

1. During the month ending 31 December 1976, Rho Sigma completed the system specification and the microprocessor study for the Model 600 microprocessor controller. Rho Sigma is presently negotiating with a subcontractor for the hardware necessary for the controller.

The data required for the preliminary design review was delivered along with additional data to better describe Rho Sigma's approach to the contract.

SCHEDULE

- II. Enclosure A shows, via a bar chart, the progress Rho Sigma has made toward the completion of the contract. No schedule problems are foreseen at this time.

COST

- III. This item has been deleted.

CONTROLLER REQUIREMENT STUDY

MICROPROCESSOR STUDY

SYSTEM SPECIFICATION

BLOCK DIAGRAM DESIGN

SCHEMATICS

P. C. BOARD LAYOUT

FLOW CHART

PROGRAM LISTING

PROCURE MATERIAL

FABRICATION

ELECTRICAL DEBUG

PROGRAM DEBUG

TEST & EVALUATION

ACCEPTANCE TEST

REPORTS MONTHLY

QUARTERLY REVIEW

DEVELOPMENT PLAN

VERIFICATION (ATP)

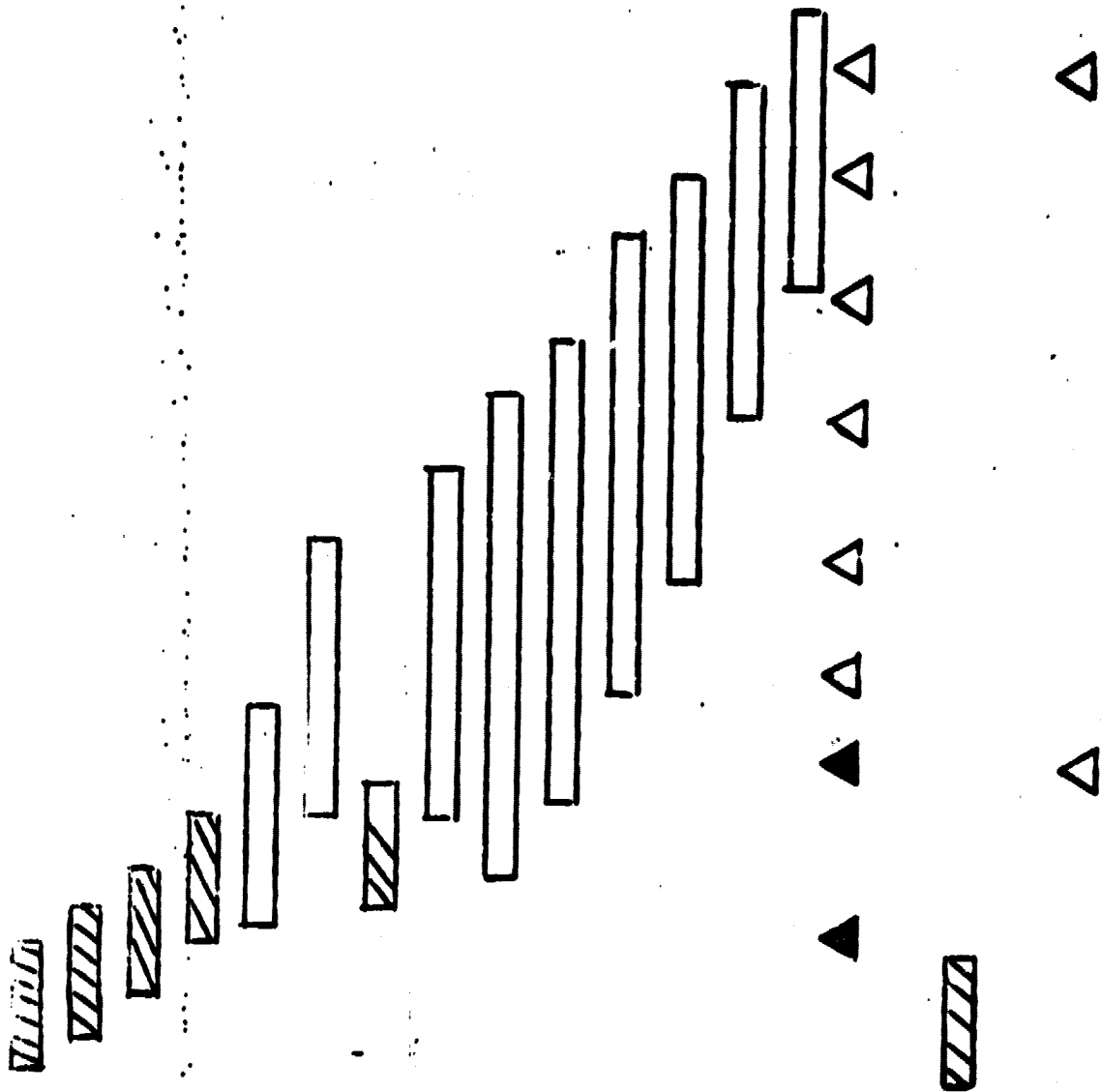
QUALITY ASSURANCE PLAN

DESIGN REVIEW

DOCUMENTATION

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RHO SIGMA, INC.

CONTRACT NAS8-32256

Second Quarterly Report (DRL-10)

May 1, 1977

February 4, 1977

TO: James D. Hankins
FROM: Joseph L. Imholte
SUBJECT: Monthly Status Report
CONTRACT: NAS8-32256
PERIOD: Month Ending 31 January 1977

1. TECHNICAL PERFORMANCE

During the month ending 31 January 1977, Rho Sigma has completed negotiations with a subcontractor to design and build the necessary circuit boards to be used in the Model 600 microprocessor controller.

The preliminary design review was also completed at Rho Sigma's facility in Van Nuys, California.

Fairchild Instrumentation in San Jose, California has been given a purchase order to design the F8 based microprocessor. The contract with Fairchild will enable Rho Sigma to expand an existing system into a solar controller. This approach will allow for the final production units to be produced at a competitive price. A copy of the Fairchild proposal and Rho Sigma's purchase order is enclosed.

The preliminary design review was attended by:

Robert J. Schlesinger	- Rho Sigma
Ed S. Peltzman	- Rho Sigma
James D. Hankins	- NASA
Ken Rinaldo	- Fairchild
Dominic Norcia	- Fairchild

II. SCHEDULE

The enclosed Bar Chart has been modified to encompass Fairchild's delivery date along with Rho Sigma's task.

Voltmeters				
Full Scale Range	Resolution	Impedance (Megohms)	Bias Current TYP MAX	Overvoltage Protection VDC VRMS
±1.9999V ±19.999V ±199.99V	±100 V ±1.0mV ±10.0mV	>1000 10 10	2.5na 7.5na 250pA 750pA 250pA 750pA	200 240 500 350 500 350

ANALOG INPUT

Configuration	True instrumentation type floating differential or single ended input.
Ratiometric Operation	With external reference, or comparison voltage
Common Mode Voltage	
AC Powered Models	600 V Between input and earth ground
DC Powered Models	1 Volt P-P Between input and ground
Common Mode Rejection (With 1K Source Imbalance)	
AC Powered Models	50 to 60Hz, 100dB, slight rolloff above 60Hz
DC Powered Models	50 to 60Hz, 80dB, slight rolloff above 60Hz
Normal Mode Rejection	30dB @ 50Hz; 32dB @ 60Hz; -6dB/octave thereafter.
Overvoltage Protection	Max. input without damage - see table above.

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PERFORMANCE

Accuracy (120 days)	±0.02% of reading ±1 digit
Linearity	.005%
Max Temperature Coefficient (0 C to +55 C) of full scale of zero	30 ppm/°C .0005% F S/°C
Setting Time	900msec to 0.1% error from a (+) or (-) F S step input*

* higher filtering for increased NMR or reduced setting time is available contact factory.

DISPLAY

Type (Model 54)	7-segment planar solid state (LED): 0.5 in (1.27 cm) high numerals, readable at 30 ft.
Polarity Indication	Automatic (+) or (-) symbol
Overload Indication	"1" digit flashes when count exceeds 19999
External Hold	Last conversion is held and displayed when EXT HOLD is maintained at logic "0". Reverts to internal trigger control when EXT HOLD input is open.
Decimal Point	3 position selectable (PC card models can be externally programmed)

ENVIRONMENT/POWER REQUIREMENTS

Temperature Range	
Operating	0°C to +55°C
Non-operating	-40°C to +85°C
Relative Humidity	0 to 85% (non-condensing)
Input Voltage	See Table 1-1
Power	3.0w watts (typ)

CONVERSION CHARACTERISTICS

Conversion Time
Trigger (Rcad) Rate

50 msec
Approx. 1/second (factory set)

DIGITAL OUTPUTS

BCD parallel (optional)
BCD bit serial (standard)

18 lines, 4TTL loads (positive true)
1 count/2.2 sec, count window signal provided, 1 TTL load each
Logic "0", 1 TTL load
Logic "0" indicates -, 4 TTL loads
Logic "1", 4 TTL loads
P/NFS 00902016, TRW/Cinch® 251-22-30-410 or equiv.

Print
Polarity
Overrange
BCD Rating Connector

PHYSICAL CHARACTERISTICS

Termination
Input Mating Connector
DIN Standard

15-pin dual row connector or 8-pin terminal strip
P/N FS 97400-03, Amphenol® 225-21521-101-117 or equiv.

Size (panel cutout)
Max. depth behind bezel
w/terminal block
w/pc boards

1.772 in. (45mm) x 3.622 in. (92mm)

Weight
Case Construction
Calibration

3.8" (96.5mm)
3.7" (94mm)
14.5 oz. (411 grams) max
Molded A.B.S. meets UL 94-V-0
Front access.

RELIABILITY PROTECTION

Warranty
Burn-in/Temp. Cycling

18 months
100 hrs. at 55°C w/pwr. and temp. on/off cycles.

MODEL NUMBERING

54 ☐ ☐ ☐ ☐

Case/Digits
54=4-1/2
(1/2" LED)
Type
0=Volt
Meter

Range
5=2V/mA
7=20V/mA
9=200V/mA
Input Voltage
2=100/115vac
+10%
47-63Hz
4=220/240vac
+10%
47-63Hz
5=5VDC
±.25V

Options
0=PC card
Terminal
1=BCD
2=BCD
(600V opto
isolated)
9=Terminal
Strip

ORIGINAL FACTORY
POOR QUALITY

R. L. Smith 1-22-77

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March 4, 1977

TO: James D. Hankins
FROM: J.L. Imholte
SUBJECT: Monthly Status Report
CONTRACT: NAS8-32256
PERIOD: Month Ending 28 February 1977

I. TECHNICAL PERFORMANCE

During the month ending 28 February, 1977, Rho Sigma conducted the design review with its sub-contractor, Fairchild Instrumentation. Rho Sigma also completed the preliminary software package and began the flow charts necessary for programming the F-8 microprocessor.

The design review was held with Fairchild Instrumentation at their Chatsworth, CA plant. Fairchild committed themselves to the specifications of the preliminary review with no exceptions. Fairchild has started charging hours to the packaging of the card cage and individual printed circuit board.

The design review with Fairchild was attended by:
Robert J Schlesinger - Rho Sigma, Inc.
Joseph L Imholte - Rho Sigma, Inc.
Ken Rinaldo - Fairchild Instrumentation

Rho Sigma, Inc. has written a preliminary program specification which was reviewed with Fairchild Instrumentation at the above meeting. The necessary program block diagram and a total program flow diagram are being worked on by Rho Sigma at this time.

II. SCHEDULE

The enclosed bar chart shows the status of key events. As of this time the actual progress to making the predicted. The prototype design date was rescheduled from the middle of May to the middle of March.

III. COST

This section has been deleted.

II SCHEDULE

The enclosed bar chart shows the status of key events. The prototype design date is now scheduled for 28 April, 1977.

III COST

This item has been deleted.

SUPPORT TASK	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY
CONTRACT REC.								
M. P. DESIGN								
CONTRACT REC.								
PRINTED CIRCUIT BOARD								
KEYBOARD DESIGN AND TEST								
SOFTWARE DEVELOP.								
PRO SIGMA'S ACCEPT.								
FINAL PACKAGE								
ACCEPTANCE TEST								
MONTHLY REPORTS								
QUARTLY REVIEW								
PRELIM. DESIGN REVIEW								
PROTOTYPE DESIGN REVIEW								
FIRST ARTICLE REVIEW								

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April 7, 1977

TO: James D. Hankins
FROM: J. L. Imholte
SUBJECT: Monthly Status Report
CONTRACT: NAS8-32256
PERIOD: Month Ending 31 March, 1977

I TECHNICAL PERFORMANCE

During the month of March, 1977, Rho Sigma met with NASA and IBM and conducted a "preliminary" prototype design review. Rho Sigma's subcontractor, Fairchild, has built the breadboard and begun the P.C. board card design. Rho Sigma has completed the preliminary programming flow charts.

The review held in Huntsville, Alabama was attended by:

James D. Hankins	MSFC
James R. Currie	MSFC
Paul Hamby	MSFC
T.N. Vann	MSFC
Thevis Barton	IBM
W.W. Scott	IBM
B. J. Doran	MSFC
R. J. Lewedag	MSFC
J. L. Imholte	Rho Sigma
R. J. Schlesinger	Rho Sigma

Although the necessary data was not available for the prototype design review; the system was reviewed and questions answered. The official prototype review will be held at Rho Sigma's plant in Van Nuys, California on 28 April 1977.

Fairchild Systems has been contacted and they are on schedule and will provide the necessary documentation for the prototype review.

The preliminary flow charts for the RS 600 program are finished and will be reviewed with Fairchild.

RHO SIGMA, INC.

Contract NAS8-32256

Third Quarterly Report (DRL-10)

August 1, 1977

May 9, 1977

TO: James D. Hankins
FROM: J.L. Imholte
SUBJECT: Monthly Status Report
CONTRACT: NAS8-32256
PER
PERIOD: Month Ending 30 April, 1977

I. TECHNICAL PERFORMANCE

During the month of April, 1977, Rho Sigma held the Prototype Design Review at its Van Nuys Plant, delivered the finalized programming specifications and flow charts and reviewed the system with Fairchild.

The Prototype Design Review was conducted at Rho Sigma's Van Nuys, CA. plant. The review was attended by:

James D. Hankins	MSFC
E. S. Pletzman	Rho Sigma
Joseph L Imholte	Rho Sigma
David W. Corbin	Fairchild

The review covered the data package sent to NASA and all of the RID's resulting. Both Fairchild and Rho Sigma were aware of the RID's and appropriate action is being taken.

A new date was set for the first article review. It will now be held at Rho Sigma on 13 July, 1977.

Rho Sigma held a system design review with its subcontractor, Fairchild. The finalized program specifications and flow charts, minus the exact system equations were accepted by Fairchild. Details on the display and packaging were also discussed with the design to be fixed at a later date.

Monthly Status Report Cont'd.

2. SCHEDULE

The enclosed Bar Chart shows the status of key events. The First Article Review is now rescheduled for 13 July, 1977.

3. COST

This item has been deleted.

June 9, 1977

TO: James D. Hankins
FROM: J.L. Imholte
SUBJECT: Monthly Status Report
CONTRACT: NAS8-32256
PERIOD: Month Ending 31 May 1977

I. TECHNICAL PERFORMANCE

During the month of May, 1977, Rho Sigma received the RID's from the prototype design review and completed the necessary documents to satisfy the RID's

Fairchild, the subcontractor has completed 80% of the hardware and 80% of the program for the Microprocessor necessary to operate the RS 600.

II. SCHEDULE

The enclosed bar chart shows the status of key events.

II. COM

This item has been deleted.

ACTIVITY	COT	NOV	DEC	JAN	FEB	MAR.	APR.	MAY
CONTRACT AND STORY								
PRODUCTION								
REVISIONS								
CONTRACTOR A								
PRINTED CIRCUITS								
CARD DESIGN								
KEYBOARD DESIGN								
AND TEST B.								
SOFTWARE DEVELOP								
PHO SIGMA'S								
ACCEPT								
FINAL PACEGE								
ACCEPTANCE								
TEST								
MONTHLY								
REPORTS								
QUARTLY								
REVIEW								
PRELIM. DESIGN								
REVIEW								
PROTOTYPE DESIGN								
REVIEW								
FIRST ARTICLE								
REVIEW								

July 13, 1977

TO: James D. Hankins
FROM: J.L. Imholte
SUBJECT: Monthly Status Report
CONTRACT: NAS8-32256
PERIOD: Month Ending 30 June, 1977

I. TECHNICAL PERFORMANCE

Rho Sigma reviewed the RS 600 with Fairchild during this reporting period. The first unit is undergoing program check out. The hardware is operational and the software is approximately 90% operational. Rho Sigma is scheduled to take acceptance of the first unit on 18 July, 1977 and should be ready for the first article review on 4 August, 1977.

No major problems were encountered during the review and the system operations via the keyboard was exercised and noted so that work can continue on the operations manual.

II. SCHEDULE

The enclosed bar chart shows the schedule and status of key events.

III. COST

This item has been deleted.

SUPPORT TASK	OCT.	NOV.	DEC.	JAN.	FEB.	MAR.	APR.	MAY	JUN
CONTROL REQ. STUDY									
M PROCESSOR STUDY									
SYSTEM SPEC.									
CONTROLLER A BREADBOARD									
PRINTED CIRCUIT A CARD DESIGN									
KEYBOARD DESIGN AND TEST A									
FINAL PACKAGE									
ACCEPTANCE TEST									
MONTHLY REPORTS									
QUARTLY REVIEW									
PRELIM. DESIGN REVIEW									
PROTOTYPE DESIGN REVIEW									
FINAL ARTICLE REVIEW									

PROGRESS SCHEDULE